Attachment 10

Assessment of Construction Noise Effects prepared by Marshall Day Acoustics

MARSHALL DAY Acoustics

BLEDISLOE AND FERGUSSON WHARVES CONSTRUCTION NOISE

Rp 001 R03 20240240 | 4 February 2025

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Project: **BLEDISLOE AND FERGUSSON WHARF EXTENSIONS**

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1.0 SUMMARY

Port of Auckland Limited (PoAL) is seeking resource consent for the construction of a new wharf at the northern end of the Bledisloe Terminal and an extension to the Fergusson Terminal (the Project) under the Fast-track Approvals Act 2024. PoAL has engaged Marshall Day Acoustics (MDA) to prepare this construction noise assessment for the Resource Consent application.

In summary:

- Construction could occur 24/7, except for vibro and impact pile driving, which would be limited to daylight hours only. This constraint will enable effective marine mammal observation.
- Construction activities are predicted to readily comply with the construction noise limits for people.
- We have predicted potential auditory injury and behavioural response zones for the marine fauna identified in the ecology assessment[1]:
    - The underwater temporary threshold shift (TTS) zones are < 200m for vibro pile driving (proposed driving method) and up to 2,350m for impact pile driving (contingency driving method). If impact pile driving is required, use of a bubble curtain would reduce the largest zone to 825m.
    - The underwater behavioural response zones for impact pile driving encompass most of the eastern Waitematā Harbour. Vibro pile driving underwater behavioural response zones are considerably smaller.
    - The airborne behavioural response zones for little penguins are all < 150m
    - We have provided our predicted zones to the project ecologist, and they have assessed the potential noise effects on the species of interest
    - We have recommended mitigation and management measures to control underwater noise effects as far as practicable. These recommendations align with current best practice.

We have prepared a draft underwater construction noise management plan (UCNMP) which incorporates our recommendations[2].

A glossary of technical terminology used in this report is provided in Appendix A.

The Proposed plans are included in Appendix B.

2.0 THE PROJECT

2.1 Overview

PoAL is proposing to construct a new 330m long and 27.5m wide wharf to the northern end of the Bledisloe Terminal for roll on roll off and large cruise ships and a 45m x 34m wide extension to the length of the existing Fergusson North Berth to accommodate larger container ships.

The Project will enable PoAL to reconfigure its operational footprint to create efficiencies in operations at the Bledisloe and Fergusson terminal areas, and enable the transfer of Captain Cook and Marsden Wharves to Auckland Council for public use in due course.

[1] '*BLEDISLOE NORTH WHARF & FERGUSSON NORTH WHARF EXTENSION CONSTRUCTION – EFFECTS ON THE ECOLOGICAL ENVIRONMENT*', Kennedy Environmental Limited (Revision 4, February 2025)

[2] 'Rp 002 R01 20240240 BL (PoAL Bledisloe and Fergusson wharves - CNMP)', dated 4 February 2025

The new wharf at the Bledisloe Terminal ("**Bledisloe North Wharf**") will accommodate multi-cargo vessels, including the relocation of RORO vessels from Captain Cook Wharf. The new wharf will accommodate cruise ships that are over 300m in length thereby enabling a reduction in the size of cruise ships berthing at Princess Wharf (<300m). It will also free up the Fergusson Terminal for container cargo.

The extension to the existing Fergusson Terminal will enable quay cranes to access the full length of the berth, removing current inefficiencies and constraints on the loading and unloading of vessels. While the existing Fergusson Terminal can accommodate up to 10,000 teu ships, the quay cranes cannot access the full length of the ship, meaning that the ships are either required to be repositioned mid-call (losing 2-3 hours for the loading / unloading) or be subject to loading restrictions (which are often unworkable in the context of international shipping).

2.2 Construction Methodology

A Beca memo provides detail on the indicative construction methodology[3].

We understand that all necessary capital dredging and reclamation works at Fergusson North are authorised by existing consents. Therefore, the effects of these activities are not addressed by this assessment.

We understand the new wharf at Bledisloe North and extension at Fergusson North wharves are supported by five and six rows of piles respectively. The steel piles will be approximately 900mm diameter, except the row at the top of the revetment will be approximately 1200mm diameter.

The Beca memo summarises the indicative wharves construction methodology and sequencing. Key components for this assessment are:

- Remove existing rocks, prepare toe trench and revetment slope with a long reach excavator and/or backhoe dredge
- Install new piles in two stages (i.e. piling at BN and FN will not occur at the same time):
    - Install temporary 2m (approx.) diameter pile casings to remove rocks with a clamshell bucket or similar
    - Drive permanent 900mm or 1,200mm diameter piles within the casings with a vibratory hammer where practicable
    - Drill out material from pile, install reinforcement cage in pile and fill with concrete
    - Break down the top of the pile for connection to the wharf deck structure
- Place rock armour with long reach excavator
- Place precast concrete beams and cast in-situ topping deck and rock revetment mattress

The commitment to prioritise the use of a vibro hammer minimises the airborne and underwater noise emissions. However, in our experience, an impact hammer is sometimes required as a subsequent secondary driving method to reach sufficient embedment. Therefore, we have also assessed impact pile driving in this assessment as a contingency method.

We understand construction could occur 24/7, except for vibro and impact pile driving, which would be limited to daylight hours only. This constraint will manage noise effects on people and enable effective marine mammal observation (elaborated in Section 5.6).

[3] BECA report 3237885-1057951712-12379, dated 20 Sep 2024

The following pile driving rates have been provided by POAL[4]:

- 1 – 2 piles installed per day for Bledisloe Wharf
- 2 – 3 piles installed per day for Fergusson Wharf

We have assumed the following representative pile driving rates based on similar projects on the Auckland waterfront and at other New Zealand ports to assess underwater noise:

- 30 minutes of vibro driving per pile
- 1,000 impact strikes per pile (contingency)
- The water depth in the piling areas range from 0 – 14m.

3.0 AUCKLAND UNITARY PLAN

3.1 Zoning

The Auckland Unitary Plan Zones Map is shown over and aerial image in Figure 1. In general:

- The red and purple areas in central Auckland are Business Zones (i.e. city)
- The yellow and beige areas to the north and east are Residential Zones (i.e. suburbs)
- The green areas are Open Space Zones (i.e. parks)
- The blue areas are Coastal Zones (i.e. sea)
- The red lines identify the boundaries of planning Precincts that contain overlay rules

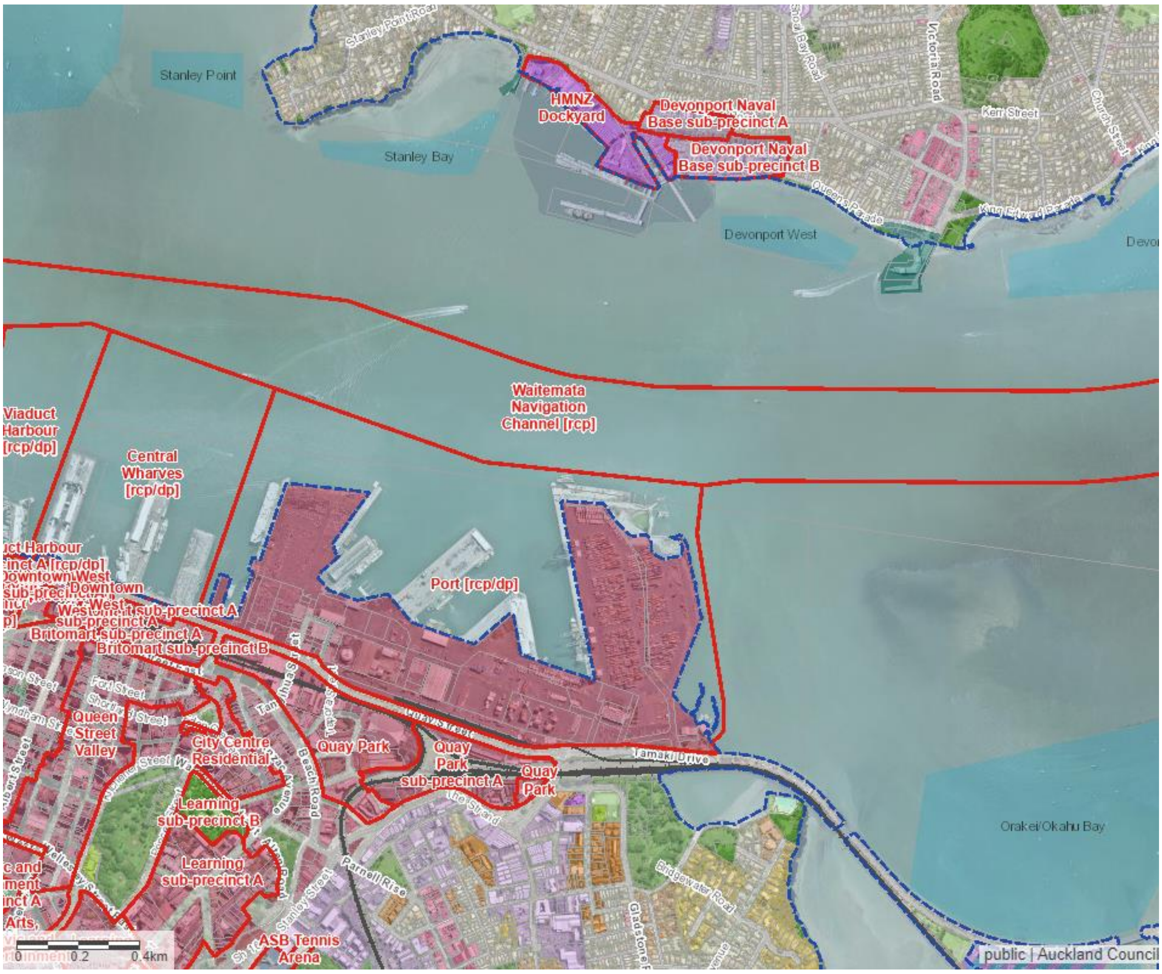
Port of Auckland operates in the Port and Waitematā Navigation Channel Precincts, on land in the Business City Centre Zone and water in the General Coastal Marine Zone. The port land is bordered by Quay Street and Tāmaki Drive to the south. Modern high-rise commercial and residential apartments occupy the immediate receiving environment, with older low-rise residential dwellings further afield in Parnell to the east and Devonport to the north.

The project works are entirely within the Port Precinct and at significant distance from receivers. The closest noise sensitive receivers outside the Port are:

- Bledisloe North Wharf:
  - Business Zone on the south side of Quay Street: 550m
  - Residential Zone to the north (Stanley Point): 1.2km
  - Residential Zone to the east (Parnell): 1.3km
- Fergusson North Wharf:
  - Business Zone on the south side of Quay Street: 830m
  - Residential Zone to the north (Devonport): 1.1km
  - Residential Zone to the south (Parnell): 900m

[4] Email from Alastair Kirk (POAL) to Paul Kennedy (ecologist) on 18 October 2024

Figure 1: Auckland Unitary Plan Map[5]



3.2 General Coastal Marine Zone (F2)

F2.18 includes objectives and policies relating to the management of the adverse effects of underwater noise on marine fauna. Table F2.19.8 (A114) classifies "*underwater blasting, impact and vibratory piling, and marine seismic surveys*" as restricted discretionary activities. Therefore, an assessment of underwater noise effects is required for this project due to the use of impact and vibro pile driving methods.

There are no underwater noise standards in the AUP. F2.23.1.3(c) identifies specific matters of discretion and F2.23.2.7 identifies assessment criteria, both of which are included in Appendix C.

An underwater noise effects assessment requires input from both an acoustician and marine ecologist. The marine ecologist identifies the relevant species of interest. The acoustician determines the relevant management zones (or effects envelopes) for the proposed works inclusive of practicable mitigation and management measures. The zones and proposed measures in this report inform the marine ecologists effects assessment.

[5] https://unitaryplanmaps.aucklandcouncil.govt.nz/upviewer/

3.3 Port Precinct (I208)

The Port Precinct noise rule I208.6.1 states that the following rules do not apply to noise and vibration from the Port Precinct:

- Coastal marine interface rule F2.21.1.1
- Auckland-wide rules E25.6.2 - E25.6.29 and E25.6.31 - E25.6.33. Construction vibration rule E25.6.30 is the remaining relevant requirement. Construction vibration is predicted to readily comply with E25.6.30. So much so, it is unlikely to be perceptible in any building outside the Port Precinct, so is not considered in any further detail in this assessment.

I208.6.1.2 provides an exception to the above. It requires that construction noise generated within the Port Precinct must comply with E25.6.28 outside the Port Precinct in the Business – City Centre Zone (i.e. south side of Quay Street).

This assessment focuses on compliance with E25.6.28. The relevant construction noise limits from E25.6.28 for a total construction duration of 15 consecutive calendar days or more are summarised in Table 1. Construction noise must be measured and assessed in accordance with the provisions of New Zealand Standard NZS 6803:1999 '*Acoustics - Construction Noise*'. The noise limits apply at 1m from the façade of any occupied building outside the Port Precinct.

Table 1: Construction Noise Limits (AUP(OP) Table E25.6.28.2)

Day	Time	$L_{Aeq\,(30min)}$	L_{AFmax}
Monday to Friday	0630 – 2230	75	90
Saturday	0700 – 2300	80	90
Sunday	0900 – 1900	65	85
All other times (night-time)		60	75

There are no Port Precinct construction noise limits applying at the Residential interface (i.e. to the north or east of the port). However, for benchmarking purposes effects, we note that the long-term residential interface night-time noise limits for day-to-day port operations in I208.6.1.1 is 50 dB L_{Aeq} and 75 dB L_{AFmax}, with an allowance for levels up to 5 decibels higher for short-term intervals. We have used 50 dB L_{Aeq} and 75 dB L_{AFmax} as an onset of effects thresholds for this assessment.

4.0 CONSTRUCTION NOISE EFFECTS ON PEOPLE

Pile driving will easily be the loudest construction activity, so is the focus of the daytime assessment. Other construction activities will be indistinguishable from normal port activities.

In our experience, large concrete pours often commence before dawn, but will be indistinguishable from normal port activities at night.

Table 2 presents the representative levels from intensive construction activities without any specialist mitigation measures. Pile driving noise levels can be variable, so we have provided conservative and more representative predicted noise levels via upper and lower ranges. Periods of low activity and inactivity are generally much quieter and are not addressed further.

Table 2: Construction noise levels at 1m from a building facade

Equipment	Sound Power	Façade Noise Level (dB L_{Aeq})			
	(dB L_{WA})	100m	550m[6]	900m[7]	1.3km[8]
Vibratory pile driving:					
- upper range	116	71	56	52	49
- lower range	106	61	46	42	39
Impact pile driving (contingency):					
- upper range	123	78	63	59	56
- lower range	114	69	54	50	47
Long reach excavator	106	61	46	42	39
Concrete truck and pump	103	58	43	39	36

In summary, we predict:

- 43 – 63 dB L_{Aeq} at the Business Zone on the south side of Quay Street
- 36 – 56 dB L_{Aeq} at the Residential Zone interface to the north and east

If two rigs were driving piles simultaneously, the predicted cumulative noise level could be slightly higher (e.g. 1 – 3 decibels). This is generally an indiscernible change in level. What may be more apparent is that the cumulative duration of the overlapping pile driving appears longer in duration.

As noted in Section 2.2, vibro and impact pile driving would be limited to daylight hours only to enable effective marine mammal observation (elaborated in Section 5.6). It also has the benefit of mitigating annoyance associated with the character of the impulsive impact pile driving.

In summary, construction activities are predicted to readily comply with the airborne construction noise limits.

[6] Closest Business Zone receiver on the south side of Quay Street (refer Section 3.1)

[7] Closest Residential Zone receiver in Parnell (refer Section 3.1)

[8] Typical setback to Residential Zone interface in Parnell, Stanley Point and Parnell (refer Section 3.1)

5.0 UNDERWATER CONSTRUCTION NOISE EFFECTS ON MARINE FAUNA

5.1 Species of Interest

The following marine biota of interest were identified in the ecology assessment:

- Marine mammals including[10]:
    - Orca, common dolphin and bottlenose dolphin (occasional visitors)
    - Fur seals (occasional visitors)
    - Leopard seals (occasional visitors)
- Little penguin/kororā (breeding/moulting typically July through March)[11], closest known occupied burrow is 250m from the Fergusson Wharf extension[12]
- A range of fish species[13]

5.2 Marine Mammal Criteria

5.2.1 Physiological Effects on Marine Mammals

It is standard practice to use the *'Technical Guidance for Assessing the Effects on Anthropogenic Sound on Marine Mammal Hearing'* from the US Department of Commerce National Oceanic and Atmospheric Administration (NOAA) for underwater noise assessments in New Zealand. We refer to this document as the 'NOAA 2024 Guidelines' throughout our report.

The NOAA 2024 Guidelines provide auditory injury thresholds and auditory weighting curves for all marine mammals identified in the ecology assessment. These thresholds and weightings are used in our underwater noise model to determine potential auditory injury zones.

We note the 2024 iteration of the NOAA Guidelines are a recent update[14] with revised auditory weighting curves and auditory injury thresholds based on the *"best available information on the effects of anthropogenic sound on marine mammals' hearing"*. The key changes are as follows:

- Larger effect zones than earlier versions of the NOAA Guidelines due to the changes in hearing range and threshold for some marine mammal groups
- Changes in species group labels:
    - Re-labelling the '*mid-frequency cetacean'* species group (orca, common/bottlenose/dusky dolphin) as *'high-frequency cetaceans'*
    - Re-labelling the *'high-frequency cetacean'* group (hectors & māui dolphin) to *'very high-frequency cetaceans'*.

The criteria for the species of interest are summarised in Table 3.

[10] Section 5.4.2 of the ecology assessment

[11] Section 5.3.5 of the ecology assessment

[12] Section 5.3.6 of the ecology assessment

[13] Section 5.5 of the ecology assessment

[14] https://www.federalregister.gov/documents/2024/10/24/2024-24748/2024-updated-guidance-for-assessing-the-effects-of-anthropogenic-sound-on-marine-mammal

Table 3: Summary of NOAA 2024 Guidelines auditory injury thresholds[15]

NOAA species group	Species included	Impulsive criteria (impact piling)	Non-impulsive criteria (vibro piling)
Permanent threshold shift (PTS)			
High-frequency (HF) cetaceans	Orca, common dolphin, dusky dolphin, bottlenose dolphin	193 $SEL_{cum\ (HF)}$ 230 dB L_{peak}	201 dB $SEL_{cum\ (HF)}$
Phocid Pinnipeds (PW)	Leopard seals	183 $SEL_{cum\ (PW)}$ 223 dB L_{peak}	195 dB $SEL_{cum\ (PW)}$
Otariid Pinnipeds (OW)	Sea lions and fur seal	185 $SEL_{cum\ (OW)}$ 230 dB L_{peak}	199 dB $SEL_{cum\ (OW)}$
Temporary threshold shift (TTS)			
High-frequency (HF) cetaceans	Orca, common dolphin, dusky dolphin, bottlenose dolphin	178 $SEL_{cum\ (HF)}$ 224 dB L_{peak}	181 dB $SEL_{cum\ (HF)}$
Phocid Pinnipeds (PW)	Leopard seals	168 $SEL_{cum\ (PW)}$ 217 dB L_{peak}	175 dB $SEL_{cum\ (PW)}$
Otariid Pinnipeds (OW)	Sea lions and fur seal	170 $SEL_{cum\ (OW)}$ 224 dB L_{peak}	179 dB $SEL_{cum\ (OW)}$

5.2.2 *Behavioural Effects on Marine Mammals*

Behavioural responses to underwater noise can vary significantly depending on species, the noise environment, and the frequency content of the noise source. These effects can range from temporary avoidance of the noisy area to disorientation or impeded communication. Behavioural responses may also be context-specific (animals may exhibit disturbance differently during their breeding season, for example), and some individual animals may be more affected than others (e.g., mothers with young may respond differently to lone males)[16].

The NOAA Fisheries 'Level B harassment' thresholds are typically used to estimate behavioural response zones for marine mammals in New Zealand. The U.S. Marine Mammal Protection Act[17] defines Level B harassment as:

> *"… acts that have the potential to disturb (but not injure) a marine mammal or marine mammal stock in the wild by disrupting behavioural patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering."*

The National Marine Fisheries Service (NFMS)[18] presents the thresholds as follows:

> *"Marine mammals are likely to be behaviourally harassed in a manner that qualifies as Level B harassment when exposed to underwater noise above root-mean-square (RMS) received levels of 120 dB re 1 µPa for continuous (e.g. vibration pile driving, drilling) and*

[15] SEL_{cum} thresholds are in µPa².s and L_{peak} thresholds are in µPa

[16] Southall BL, Nowacek DP, Bowles AE, Senigaglia V, Bejder L, Tyack PL(2021) Marine mammal noise exposure criteria: assessing the severity of marine mammal behavioural response to human noise. Aquat Mamm 47:421–464

[17] https://www.fisheries.noaa.gov/topic/laws-policies/marine-mammal-protection-act

[18] https://www.fisheries.noaa.gov/s3/2024-10/MM-Acoustic-Thresholds-OCT2024-508-secure-OPR1.pdf

160 dB re 1 µPa or non-explosive, impulsive (e.g. seismic airguns, impact pile driving) or intermittent (e.g. scientific, nontactical sonar) sources."

There are several limitations to the above thresholds that should be considered:

- The criteria are 'un-weighted' and do not consider the frequency range where marine mammals are sensitive to noise. The zones would be smaller if the criteria were weighted as per the auditory injury thresholds.
- The thresholds do not account for the ambient noise environment. The 120 dB RMS threshold for non-impulsive noise sources is relatively low, and may be conservative in environments such as the Waitematā Harbour due to the elevated ambient noise levels from marine traffic.
- 160 dB RMS for impulsive sources appears to be a relatively high threshold and results in behavioural response zones that can be smaller than the auditory injury zones for some species.

5.3 Fish Criteria

5.3.1 Physiological Effects

Table 2 of the 2019 publication *'An overview of fish bioacoustics and the impacts of anthropogenic sounds on fishes'* (Popper 2019) provides comprehensive sound exposure guidelines for fishes[19]. These criteria have been used to assess the effects of the proposed impact piling on fish species.

The most stringent thresholds (for fish which have a swim bladder involved in hearing – e.g. sharks) are as follows:

- Mortality: 207 dB re. 1 $\mu Pa^2 s$ $SEL_{cum\ (unweighted)}$ or 207 dB re. 1 μPa L_{peak}
- TTS: 186 dB re. 1 $\mu Pa^2 s$ $SEL_{cum\ (unweighted)}$

5.3.2 Behavioural Effects

Studies on the behavioural impacts from noise on fish are very limited and there is not widely accepted or validated guideline criteria. This lack of information is partly due to the practicalities of conducting such studies in the field, as well as the potential for large variations in responses across all fish species.

The Californian Department of Transportation (CALTRANS) has conservatively used 150 dB re. 1 μPa rms as the threshold for behavioural effects[20]. Section 4.6.4.2 of CALTRANS states the following:

"As a conservative measure, NOAA Fisheries and USFWS generally have used 150 dB RMS as the threshold for behavioural effects on FESA-listed fish species (salmon and bull trout) for most biological opinions evaluating pile driving, citing that sound pressure levels in excess of 150 dB RMS can cause temporary behavioural changes (startle and stress) that could decrease a fish's ability to avoid predators. As of this writing, neither NOAA Fisheries nor USFWS has provided any research data or related citations to support this threshold. Nonetheless, until further research is conducted, it should be anticipated that NOAA Fisheries and USFWS will expect to see a discussion in BAs of the effects of pile driving on fish behaviour, with reference to the 150 dB RMS threshold. NOAA Fisheries staff informally

[19] These thresholds are the same as in Section 7.5.2 of the 2014 publication *'Effects of Sound on Fish and Turtles'*. These criteria were prepared by an ANSI-accredited Standards Committee Working Group of experts and was sponsored by the Acoustical Society of America.

[20] California Department of Transportation (CALTRANs), '*Technical Guidance for Assessment of Hydroacoustic Effects of Pile Driving on Fish*', October 2020.

indicated at the June 2008 FHWG meeting that they do not expect exceedance of the 150 dB RMS behaviour threshold to trigger any mitigation requirement (FHWG 2008).”

5.4 Little penguin (kororā) criteria

5.4.1 Physiological effects

We are not aware of any established thresholds for the onset of auditory injury for penguins.

We have instead applied thresholds and weightings for other carnivores in water (OCW) from Southall et al. (2019) as a proxy due to the similarity in hearing sensitivity in the frequency band of underwater hearing for the two species groups. The thresholds are as follows:

- Non-impulsive noise:
  - TTS: 199 dB $SEL_{cum\,(OCW)}$ re. 1 µPa^2.s
  - PTS: 219 dB $SEL_{cum\,(OCW)}$ re. 1 µPa^2.s
- Impulsive noise:
  - TTS: 188 dB $SEL_{cum\,(OCW)}$ re. 1 µPa^2.s, 226 dB L_{peak} re. 1 µPa
  - PTS: 203 dB $SEL_{cum\,(OCW)}$ re. 1 µPa^2.s, 232 dB L_{peak} re. 1 µPa

5.4.2 Behavioural effects

We are also not aware of any established underwater noise behavioural response thresholds for penguins.

We have instead applied the Sørensen et al. (2020) behavioural response threshold of 120 dB RMS re. 1 µPa. This study showed that a majority of captive gentoo penguins in a controlled experiment showed strong aversive reactions to impulsive noise at received levels above this threshold.

The Sørensen et al. experiment used 500 ms bursts of noise (assumed to be white noise) that was filtered to include noise between 200 Hz – 6 kHz, played on an underwater speaker. We have applied the same filters to our piling noise predictions to align with the experiment results.

5.5 Noise Model

5.5.1 Overview

We have used dBSea[21] software to predict underwater noise levels from pile driving.

There are no defined New Zealand or international standards for calculating underwater noise propagation from marine pile driving. However, there are several established analytical methods which are routinely used for impact assessment purposes, referred to as solvers. dBSea is a proprietary software package that enables noise propagation to be calculated in complex underwater environments using the following solvers:

- ‘dBSeaPE’ or ‘Parabolic Equation’ (comparable to the RAM solver)
- ‘dBSeaRay’ or ‘Ray Trace’ (comparable to the Bellhop solver)
- ‘dBSeaModes’ or ‘Normal Modes’ (comparable to the Kraken solver).

More information on the solvers and validation can be found here.

[21] https://www.dbsea.co.uk/

Our underwater noise model incorporates local bathymetry, water column and seafloor properties, source characteristics and mitigation to produce a 3D underwater sound field grid from 2D 'slices'. The underwater noise contours are produced from interpolation of these grid points.

We have used the dBSeaPE solver from 12.5 Hz – 630 Hz and the dBSeaRay solver from 800 Hz – 125 kHz to calculate underwater noise levels for this project.

The Waitematā contains breakwaters, reclamations and land masses that block line of sight from the piling to some bays around the harbour. The key areas are bounded by Bean Rock Lighthouse to the east, Auckland Harbour Bridge to the west, Oneoneroa/Shoal Bay and Ngataringa Bay to the North, and Judges Bay to the South.

The solvers in dBSea currently do not predict underwater noise levels around corners, and so the results may be locally underestimated in these bays. Nonetheless, we consider the auditory injury and behavioural zones to be appropriate for assessment purposes because:

- The piling has line of sight to the entrance to the harbour and relevant bays
- Areas without line of sight to the piling are likely to be below 120 dB RMS and primarily low frequency based on our preliminary modelling with a 3D solver.

We have not modelled L_{peak} levels because the corresponding auditory injury zones are significantly smaller than the cumulative auditory injury ones detailed below.

5.5.2 *Base data inputs*

Our input data for the underwater noise model is summarised in Table 4.

Table 4: Summary of underwater noise model input data

Type	Dataset/value
Bathymetry	Waitematā Harbour Dataset from LINZ and dredged areas from POAL
Sea floor materials	Silt from 0 – 4m below seafloor level, sandstone below.
Sound speed profile	Constant sound speed profile of 1,500 m/s
Water temperature	18°C
Salinity	35 ppt
Sound source	Shallow water piling noise measurements from MDA database
Mitigation	MDA measurements of various single ring bubble curtains in shallow water
	Inclusion of a hammer cushion
Water depth at modelled piling location	12m
Marine fauna effects criteria	NOAA Guidance (marine mammals) & Popper et al. 2014 (fish)

5.5.3 *Noise source data*

We have a large database of validation measurements of driving steel piles in shallow water environments. This measurement data can be used to back calculate theoretical point source levels and spectra for projects in comparable environments.

Our source levels for this project are based on our measurements of vibro driving and impact driving 1,000 mm steel piles in a water depth of 10m with a silt seafloor near the piling (comparable conditions to the Bledisloe and Fergusson Wharf berths).

The vibro hammer was an ICE 28RF and the impact hammer was a BSP HH357-9 hydraulic hammer with a 9 T weight and hammer cushion. Photos of the equipment are shown in Figure 2.

Figure 2: Vibro hammer (left) and impact hammer (right) source data used in our model

The measured levels for this equipment were at the upper end of our database of shallow water piling noise measurements. We used a 15xlog(distance) propagation equation to back calculate the source levels and spectra for this piling rig, which we have found to be suitable for close proximity measurements in shallow water.

Table VI-1 of the 2020 version of California Department of Transportation: '*Technical Guidance for Assessment and Mitigation of the Hydroacoustic Effects of Pile Driving on Fish'* (CALTRANS) contains a comprehensive database of unmitigated impact piling source levels. The CALTRANS source levels for impact driving 900 mm and 1,200 mm piles are 7 – 8 dB louder than our calculated source level for the 1,000 mm diameter piles. This is expected when comparing rigs with and without a dolly/hammer cushion.

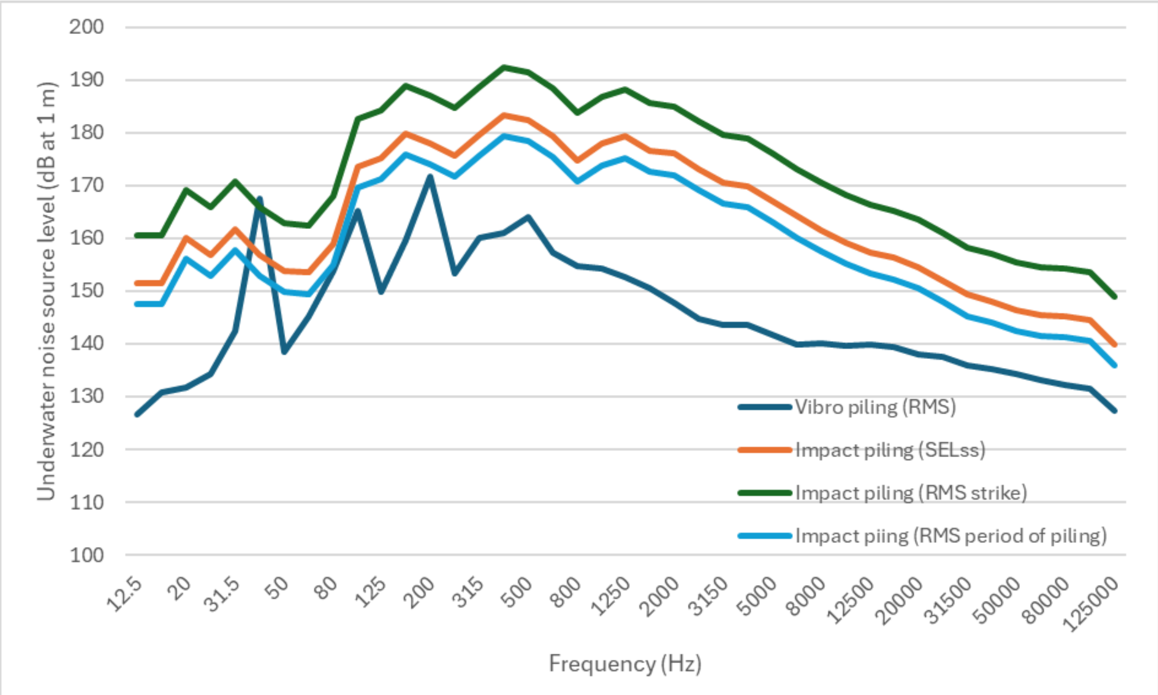
The CALTRANS database also indicates that there is negligible difference between 900 mm and 1,200 mm piles. We therefore consider our measurements of the driving the 1,000 mm diameter piles to be representative of all pile driving works for this project.

Our predicted source levels are shown in Table 5 and the source spectra are presented in Figure 3. They rely on the representative piling rates detailed in Section 2.2.

Table 5: Source levels used for underwater noise predictions (unweighted)

Parameter	Calculated source level
Impact piling	
SEL (single strike)	191 dB SEL re 1 µPa².s
SEL (cumulative 24 hour) – 2,000 strikes per day for Bledisloe Wharf	224 dB SEL re 1 µPa².s
SEL (cumulative 24 hour) – 3,000 strikes per day for Fergusson Wharf	226 dB SEL re 1 µPa².s
RMS (pile strike)	200 dB RMS re. 1 µPa
RMS (period of piling)	187 dB RMS re. 1 µPa
Peak	222 dB RMS re. 1 µPa
Vibro piling	
SEL (cumulative 24 hour) – 60 minutes for Bledisloe Wharf	211 dB SEL re 1 µPa².s
SEL (cumulative 24 hour) – 90 minutes per day for Fergusson Wharf	213 dB SEL re 1 µPa².s
RMS (period of piling)	175 dB RMS re. 1 µPa

Figure 3: Underwater piling noise source spectra



5.6 Mitigation and Management

5.6.1 Overview

It is standard practice to implement a range of underwater noise mitigation and management on marine projects where there is the potential to impact marine fauna[22] [23].

[22] https://link.springer.com/rwe/10.1007/978-3-031-10417-6_13-1

[23] https://link.springer.com/referenceworkentry/10.1007/978-3-031-10417-6_182-1

Current best practice measures include:

1. Reducing the noise at source by selecting pile driving equipment and methodologies that generate lower noise emissions
2. Scheduling high noise works based on the ecologist's recommendations to avoid pile driving during sensitive seasonal periods, and driving to daylight hours to aid marine mammal observers
3. Mitigating noise from the piling using bubble curtains, cofferdams and similar systems to reduce noise propagating into the water column
4. Stopping/postponing works when marine fauna is present using marine mammal observers, and/or use of acoustic detectors and similar technologies to identify marine mammals in the marine mammal observation zone
5. Validating the underwater noise levels and mitigation: carrying out underwater noise measurements to validate the size of the predicted zones and review the effectiveness of mitigation and management measures.

The following sections present our specific recommendations on some of the above key measures.

Our recommendations are consistent with best practice for near shore piling projects, and based on our experience on comparable recent projects in Australia and New Zealand. They are reflected in the ecology assessment and have been included in our draft UCNMP that supports this assessment.

5.6.2 Best practice piling methodology

The construction methodology (summarised in Section 2.2) already includes a commitment to prioritise the use of a vibro hammer to minimise the airborne and underwater noise emissions.

However, in our experience, an impact hammer is sometimes required as a subsequent secondary driving method to reach sufficient embedment. Therefore, we have also assessed impact pile driving in this assessment as a contingency method. Impact hammers will have mechanisms to dampen noise levels (e.g. hammer cushions/dollies) if used.

Our noise modelling assumes a hammer cushion or dolly will be incorporated into the impact piling rig to avoid steel on steel contact. In our experience, most modern hydraulic impact hammers have some form of cushion built in, although the primary purpose is generally to prevent damage and prolong the life of the hammer, they also provide effective noise mitigation.

5.6.3 Bubble curtains

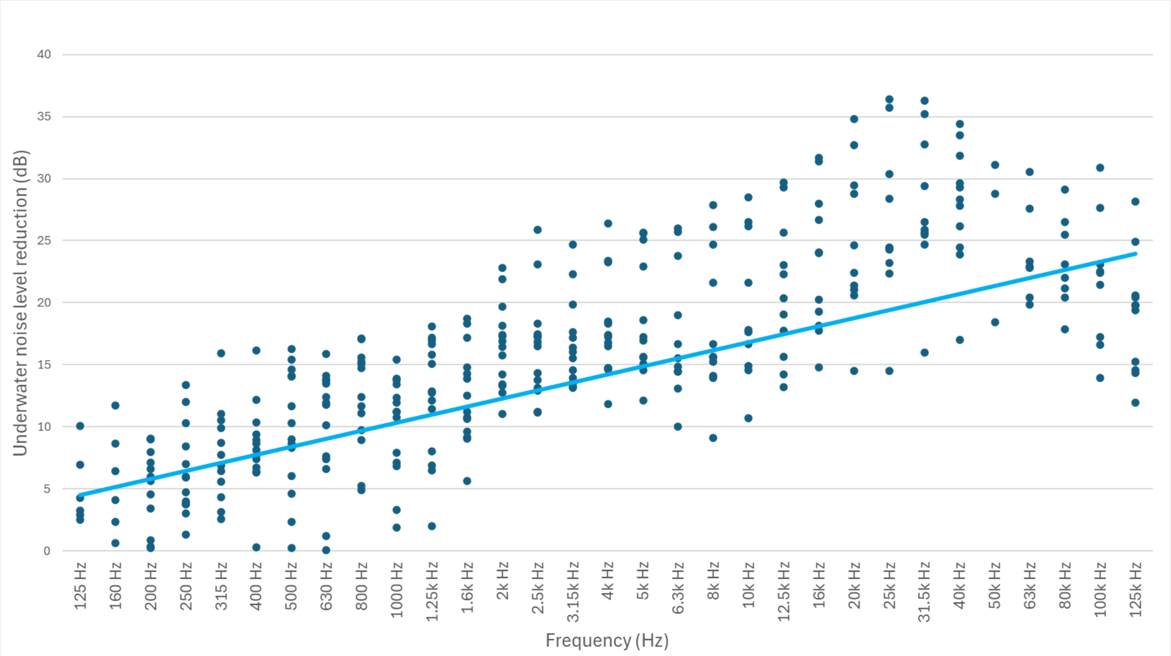
Bubble curtains are an effective and widely used mitigation measure to reduce underwater noise levels from pile driving in sensitive marine environments.

We have measured a range of single and double bubble curtain systems in shallow water marine environments comparable to this project. Our database includes 15 single bubble curtain and 4 double bubble curtain configurations across 5 separate projects. Most projects used proprietary Bubble Tubing from Canadian Pond. The bubble curtains were installed on the sea floor at separations ranging from 1 – 10m from the piles being driven.

We have used our database of 15 single bubble curtain measurements to obtain a representative typical bubble curtain performance estimate. We have arithmetically averaged the results for each of the 5 projects and used these averages to calculate the line of best fit which gives each project/system equal weighting.

Figure 4 shows the spread of data. We have used the line of best fit to calculate the piling noise levels with mitigation. These results are discussed further in the mitigation and management section.

Figure 4: Single bubble curtain measurement results (dark blue) and line of best fit (light blue)



Our general findings are:

- The bubble curtains provided underwater noise reductions of 9 – 37 dB at frequencies above 2 kHz. This significantly reduces the effect zones for high-frequency hearing groups (marine mammals such as dolphin species, orca and porpoises).
- The bubble curtain performance varied between 0 – 20 dB reduction at frequencies below 2 kHz. This means that the reduction in zones for general behavioural response, pinnipeds and fish are less pronounced than the reductions for high-frequency hearing groups.
- A double bubble curtain provides a small, but material improvement from a single curtain.
- An effective setup with a dense cloud/wall of bubble achieves the best results across the frequency range. However, our data indicates that less optimal setups still achieve significant reductions
- An increased and consistent low frequency performance may be achievable with bubble curtains that are spaced further from the pile as per larger offshore installations[24]. However, we have not been able to test/validate this expectation on nearshore/port projects to date.

We recommend a bubble curtain is used for impact pile driving.

5.7 Predicted zones

We have predicted noise levels for the following scenarios:

1. Vibro piling in the middle of the Bledisloe Wharf extension
2. Impact piling in the middle of the Bledisloe Wharf (with and without a bubble curtain)
3. Vibro piling at the eastern end of Fergusson Wharf
4. Impact piling at the eastern end Fergusson Wharf (with and without a bubble curtain)

[24] Based on the bubble curtain mitigation data presented in M. Bellman et al technical report '*Underwater noise during percussive pile driving: Influencing factors on pile-driving noise and technical possibilities to comply with noise mitigation values*' (2020).

The vibro piling results are dominated by low frequency noise. We have not included bubble curtains for this methodology because the mitigation benefit at low frequencies is small (refer Section 5.6.3)

Our predicted TTS, PTS and behavioural response zones for all species groups are included in Section 5.7.1 and Section 5.7.2 below.

Our predicted TTS and behavioural noise contours for marine mammals and little penguin are presented graphically in Appendix D. The PTS zones are only presented in the tables below as they are too small to show on the figures.

We note that the water depth at the piling location will vary from 0 – 14m. Our predicted zones are based on the seaward row of piles (i.e. those in the deepest water). In general, piling in shallower water depths will result in lower underwater noise levels in the harbour depending on the specific ground conditions at the piling location. However, the reduction is predicted to be small based on our indicative modelling, so we recommend the zones in the following sections are used for all piling works in water as a conservative approach.

5.7.1 Auditory injury zones

Table 6 and Table 7 presents our predicted PTS and TTS zones respectively.

Table 6: Predicted PTS zones

	Predicted zones (m)		
Species group	Impact pile driving (hammer cushion)	Impact pile driving (hammer cushion and bubble curtain)	Vibro pile driving
Bledisloe Wharf			
High-frequency cetaceans	< 50m	Below criteria	Below criteria
Otariid pinnipeds	< 200m	< 50m	< 50m
Phocid pinnipeds	< 200m	< 50m	< 50m
Little penguin	< 50m	< 50m	Below criteria
Fish (mortality)	< 50m	< 50m	< 50m
Fergusson Wharf			
High-frequency cetaceans	< 200m	< 50m	Below criteria
Otariid pinnipeds	400m	< 200m	< 50m
Phocid pinnipeds	525m	< 200m	< 50m
Little penguin	< 50m	< 50m	Below criteria
Fish (mortality)	< 50m	< 50m	< 50m

Table 7: Predicted TTS zones

Species group	Predicted zones (m)		
	Impact pile driving (hammer cushion)	Impact pile driving (hammer cushion and bubble curtain)	Vibro pile driving
Bledisloe Wharf			
High-frequency cetaceans	435m	< 200m	Below criteria
Otariid pinnipeds	1,460m	445m	< 200m
Phocid pinnipeds	1,645m	585m	< 200m
Little penguin	205m	< 200m	Below criteria
Fish	420m	< 200m	< 200m
Fergusson Wharf			
High-frequency cetaceans	600m	< 200m	Below criteria
Otariid pinnipeds	1,960m	655m	< 200m
Phocid pinnipeds	2,350m	825m	< 200m
Little penguin	270m	< 200m	Below criteria
Fish	580m	210m	< 200m

5.7.2 *Behavioural response zones*

Table 8 presents our predicted behavioural response zones for all species.

Table 8: Predicted behavioural response zones

Species group	Predicted zones (m)		
	Impact pile driving (hammer cushion)	Impact pile driving (hammer cushion and bubble curtain)	Vibro pile driving
Bledisloe Wharf			
All marine mammals (impulsive criteria)	525m	< 200m	N/A
All marine mammals (non-impulsive criteria)	4,050m	2,850m	2,050m
Little penguin	2,900m	1,450m	610m
Fish	380m	< 200m	< 200m
Fergusson Wharf			
All marine mammals (impulsive criteria)	610m	215m	N/A
All marine mammals (non-impulsive criteria)	4,050m	3,550m	2,880m
Little penguin	3,150m	1,750m	640m
Fish	405m	< 200m	< 200m

5.8 Marine Mammal Observation Zone (MMOZ)

The MMOZ is an area identified by the marine ecologist that must be clear of marine mammals during piling. The area is based on the predicted TTS zones as per standard practice.

Visual observation of this zone to identify marine mammals presence during piling is the residual management measure to avoid physiological effects on marine mammals (i.e. TTS and PTS). The following sections outline the typical process on site.

- **MMO**: at least one dedicated MMO is typically on continuous watch from an elevated position near the pile-driving rig. The aim of the observers is to ensure that any marine mammals entering the wider project area are promptly identified and appropriate mitigation action is undertaken if necessary. The MMO will be familiar with the standard operating procedures, keep a record of all sightings, delayed start-up, or enforced shut-downs due to presence of marine mammals.
- **Pre-start procedure**: the MMOZ is typically visually monitored by the MMO for at least 30 minutes before the commencement of the soft start procedure. Observations should be made from an elevated viewing platform near the piling rig or a better vantage point if possible.
- **Soft start procedure**: Soft start procedures may commence once 30 minutes of pre-start observations have been completed and no marine mammals have been seen within the MMOZ. Once the soft start procedure is cleared to proceed, the piling impact energy is gradually increased. The soft start procedure may alert marine mammals to the presence of the piling rig and enable animals to move away.
- **Shut-down procedure**: the piling activity should be stopped immediately If a marine mammal is sighted within or about to enter the shut-down zone.

6.0 AIRBORNE CONSTRUCTION NOISE EFFECTS ON MARINE FAUNA

6.1 Pinnipeds

NOAA provides in-air behavioural response thresholds of 90 dB L_{Zeq} for harbour seals and 100 dB L_{eq} for all other pinnipeds. We calculate the loudest activity (vibro pile driving) would comply with these thresholds at any haul out sites at least 10m from the pile being driven. The setback increases to approximately 50m if impact pile driving is required (contingency only).

6.2 Little Penguin

We carried out a detailed study into construction noise effects on little penguin during the piling works for the nearby Kennedy Point Marina project on Waiheke Island. Our findings were presented in a paper[25] that was published in The Effects of Noise on Aquatic Life: Principles and Practical Considerations. In summary, we found that controlling construction noise to generally comply with 80 dB $L_{Aeq\,(1s)}$ at an occupied burrow *"did not alter their general patterns of behaviour, and were able to successfully raise clutches and molt during and after the marina piling and construction works".*

We calculate the loudest activity (vibro pile driving) would comply with these thresholds at any burrow greater than 80m from the site. The setback increases to approximately 150m if impact pile driving is required (contingency only). We understand the closest identified burrow is 250m from the works as identified in the ecology assessment.

[25] Lawrence, B.C., Bull, L.S., Arden, S.C., Warren, V.E. (2023). Effect of Piling on Little Blue Penguins. In: Popper, A.N., Sisneros, J., Hawkins, A.D., Thomsen, F. (eds) The Effects of Noise on Aquatic Life. Springer, Cham. https://doi.org/10.1007/978-3-031-10417-6_90-1

7.0 CONCLUSION

In summary:

- Activities are predicted to readily comply with the construction noise limits for people.
- We have predicted potential auditory injury and behavioural response zones for the marine fauna identified in the ecology assessment:
  - The underwater temporary threshold shift (TTS) zones are < 200m for vibro pile driving (proposed driving method) and up to 2,350m for impact pile driving (contingency driving method). If impact pile driving is required, use of a bubble curtain would reduce the largest zone to 825m.
  - The underwater behavioural response zones for impact pile driving encompass most of the eastern Waitematā Harbour. Vibro pile driving underwater behavioural response zones are considerably smaller.
  - The airborne behavioural response zones are all < 150m
  - We have provided our predicted zones to the project ecologist, and they have assessed the potential noise effects on the species of interest
  - We have recommended mitigation and management measures to control underwater noise effects as far as practicable. These recommendations align with current best practice

APPENDIX A GLOSSARY OF TERMINOLOGY

Airborne Noise	A sound that is unwanted by, or distracting to, the receiver.
dB	Decibel (dB) is the unit of sound level. Expressed as a logarithmic ratio of sound pressure (P) relative to a reference pressure (Pr), where dB = 20 x log(P/Pr). The convention is a reference pressure of Pr = 20 μPa in air.
dBA	The unit of sound level which has its frequency characteristics modified by a filter (A-weighted) to more closely approximate the frequency bias of the human ear. A-weighting is used in airborne acoustics.
$L_{Aeq\,(t)}$	The equivalent continuous (time-averaged) A-weighted sound level commonly referred to as the average level. The suffix (t) represents the period, e.g. (8 h) would represent a period of 8 hours, (15 min) would represent a period of 15 minutes and (2200-0700) would represent a measurement time between 10 pm and 7 am.
L_{A90}	The A-weighted noise level equalled or exceeded for 90% of the measurement period. This is commonly referred to as the background noise level.
L_{AFmax}	The A-weighted maximum noise level. The highest noise level which occurs during the measurement period.
NZS 6801:2008	NZS 6801:2008 “Acoustics – Measurement of environmental sound”
NZS 6802:2008	NZS 6802:2008 “Acoustics – Environmental Noise”
Underwater noise	A sound that is unwanted by, or distracting to, the receiver underwater.
dB	Decibel (dB) is the unit of sound level. Expressed as a logarithmic ratio of sound pressure (P) relative to a reference pressure (Pr), where dB = 20 x log(P/Pr). The convention is a reference pressure of Pr = 1 μPa underwater.
Marine weighting	The unit of sound level which has its frequency characteristics modified by a filter (M-weighted) to more closely approximate the frequency bias of marine mammal hearing groups. M-weightings are used in underwater acoustics. The following marine weightings are used in this report: • Low-frequency cetaceans (LF) • Mid-frequency cetaceans (MF) • Otariid pinnipeds (OW) • Phocid pinniped (PW)
RMS	Root Mean Square (RMS) is the equivalent continuous (time-averaged) sound level commonly referred to as the average level (period matches the event duration).
L_{90}	The noise level equalled or exceeded for 90% of the measurement period. This is commonly referred to as the background noise level.
SEL	Sound exposure level (SEL) is the total sound energy of an event, normalised to an average sound level over one second. It is the time-integrated, sound-pressure-squared level. SEL is typically used to compare transient sound events having different time durations, pressure levels and temporal characteristics.
TTS	Temporary Threshold Shift (TTS) is the temporary loss of hearing caused by sound exposure. The duration of TTS varies depending on the nature of the stimulus, but there is generally recovery of full hearing over time. TTS in humans can be likened to the ‘muffled’ effect on hearing after being exposed to high noise levels such as at a concert. The effect eventually goes away, but the longer the exposure, the longer the threshold shift lasts. Eventually, the TTS becomes permanent (PTS).
PTS	Permanent Threshold Shift (PTS) is the permanent loss of hearing caused by acoustic trauma. PTS results in irreversible damage to the sensory hair cells of the ear.

APPENDIX B PROPOSED PLANS

Figure 5: Bledisloe North GA (BECA report 3237885-1057951712-12379, dated 20 Sep 2024)

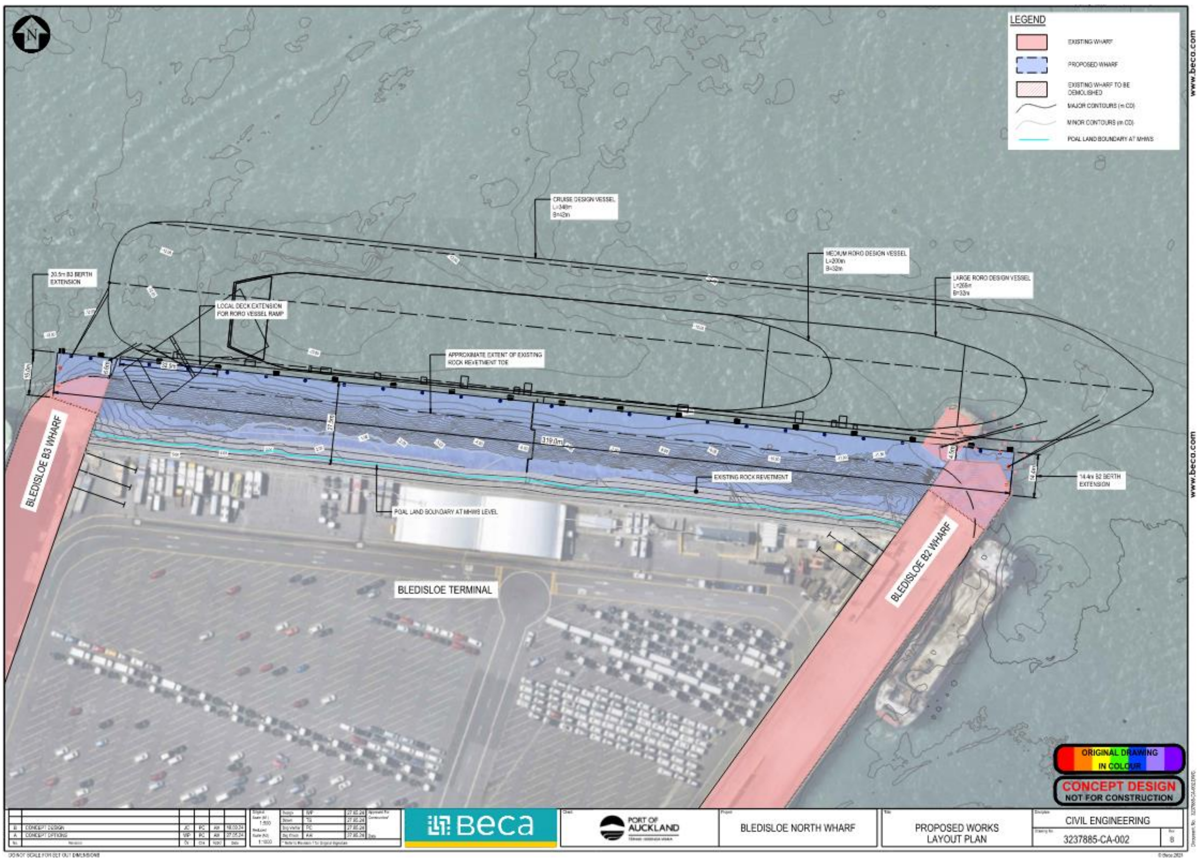
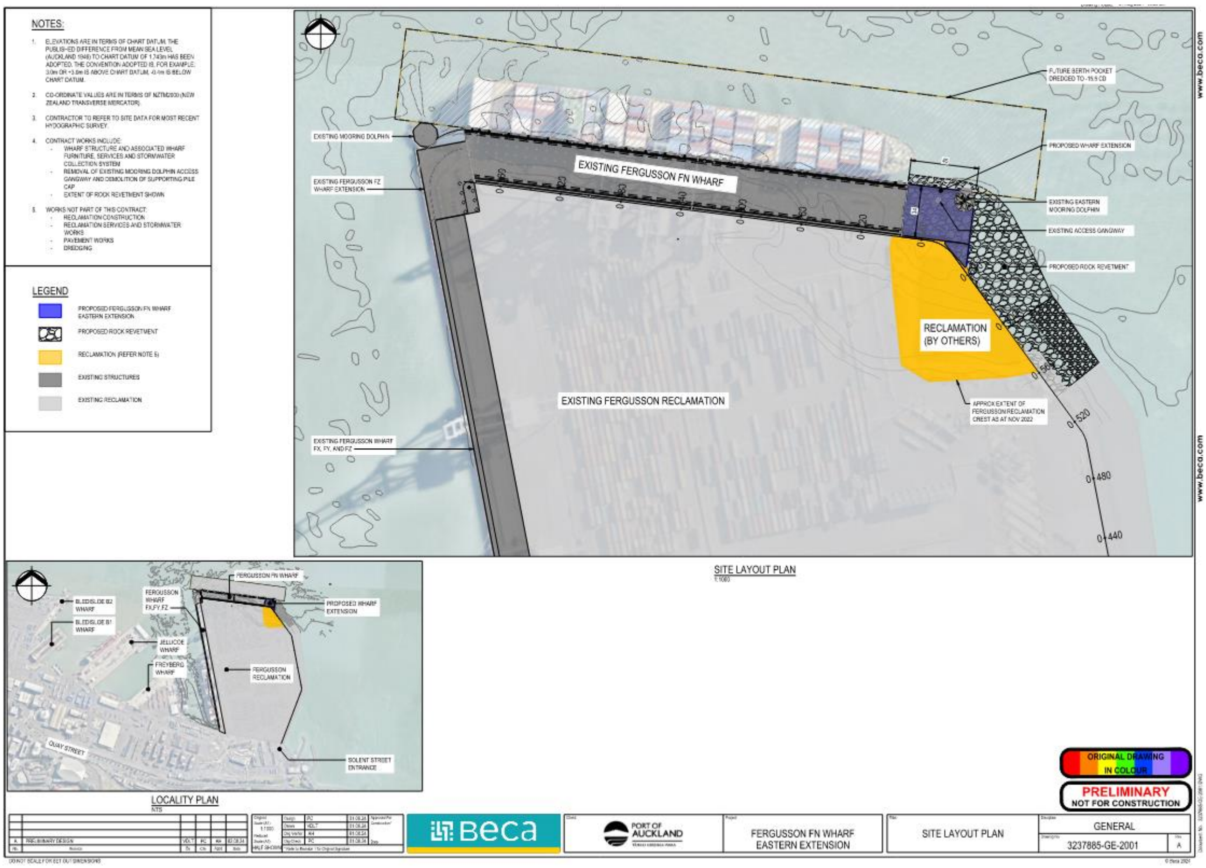


Figure 6: Fergusson FN Extension GA (BECA report 3237885-1057951712-12379, dated 20 Sep 2024)



APPENDIX C UNDERWATER NOISE MATTERS OF DISCRETION AND ASSESSMENT CRITERIA

Table 9: Matters of discretion from AUP F2.23.1.3(c)

F2.23.1.3 (c) underwater blasting, impact and vibratory piling, marine seismic surveys:	
(i)	the health and well-being of marine fauna (including threatened and at-risk species) and people from the underwater noise associated with the proposal;
(ii)	the practicability of being able to control the underwater noise effects
(iii)	the social and economic benefits of the proposal; and
(iv)	the extent to which non-transitory or more than minor adverse effects on threatened or at risk indigenous species (including Māui's Dolphin and Bryde's Whale) are avoided.

Table 10: Assessment criteria from F2.23.2(7)

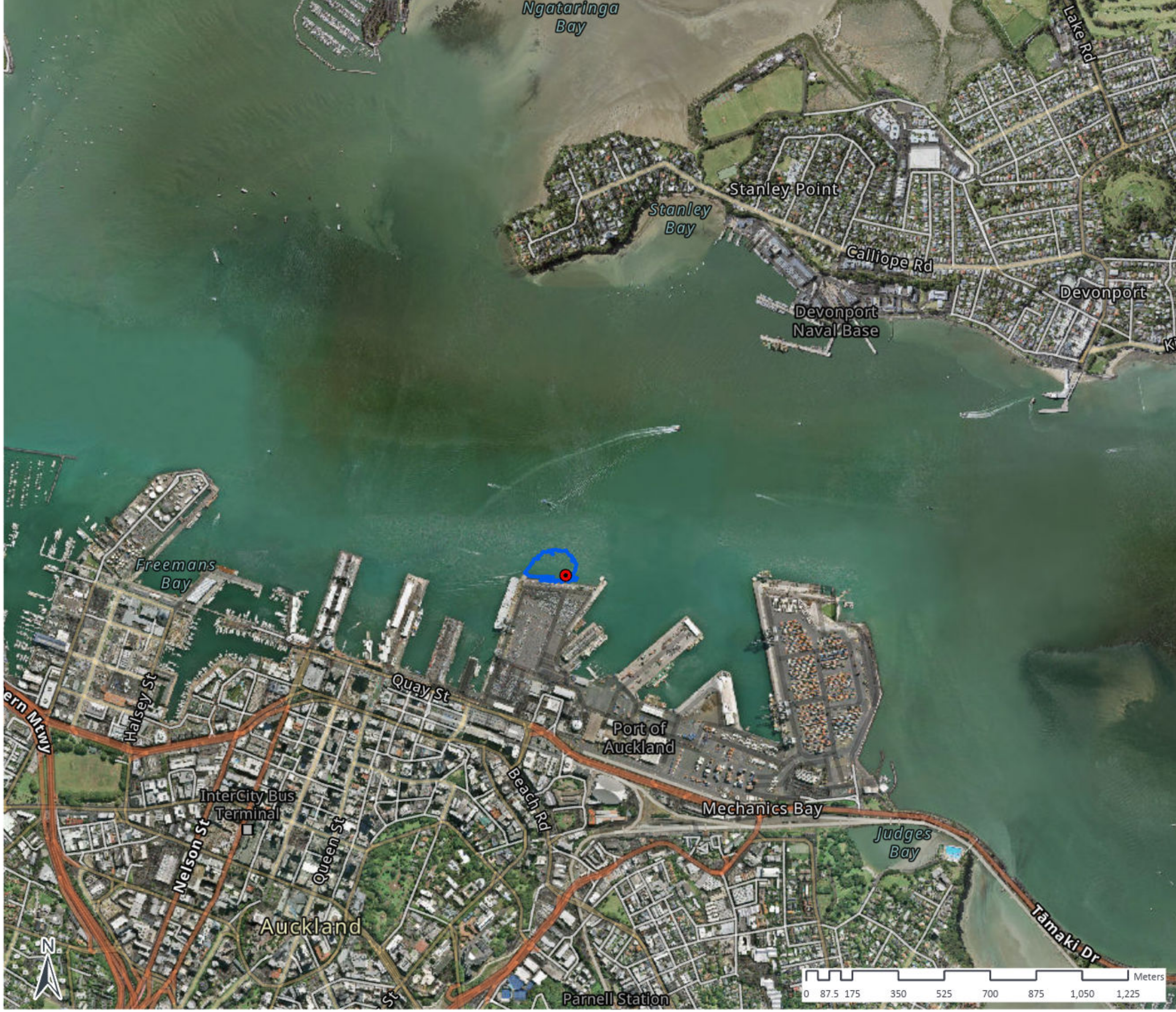
F2.23.2(7)(a) whether the proposal has included an assessment of:	
(i)	the extent to which the underwater noise associated with the proposal adversely affects the health and well-being of marine fauna and people;
(ii)	the practicability of being able to control the underwater noise effects;
(iii)	the social and economic benefits of the proposal; and
(iv)	the extent to which the adverse effects of underwater noise will be mitigated.

APPENDIX D UNDERWATER NOISE ZONES

The following underwater are attached:

- Figure 1: Bledisloe Wharf: Vibro piling TTS zones for high-frequency cetaceans
- Figure 2: Bledisloe Wharf: Vibro piling TTS zones for pinnipeds
- Figure 3: Bledisloe Wharf: Vibro piling behavioural response zones for marine mammals
- Figure 4: Bledisloe Wharf: Vibro piling behavioural response zones for little penguin
- Figure 5: Bledisloe Wharf: Impact piling TTS zones for high-frequency cetaceans
- Figure 6: Bledisloe Wharf: Impact piling TTS zones for pinnipeds
- Figure 7: Bledisloe Wharf: Impact piling behavioural response zones for marine mammals
- Figure 8: Bledisloe Wharf: Impact piling behavioural response zones for little penguin
- Figure 9: Fergusson Wharf: Vibro piling TTS zones for high-frequency cetaceans
- Figure 10: Fergusson Wharf: Vibro piling TTS zones for pinnipeds
- Figure 11: Fergusson Wharf: Vibro piling behavioural response zones for marine mammals
- Figure 12: Fergusson Wharf: Vibro piling behavioural response zones for little penguin
- Figure 13: Fergusson Wharf: Impact piling TTS zones for high-frequency cetaceans
- Figure 14: Fergusson Wharf: Impact piling TTS zones for pinnipeds
- Figure 15: Fergusson Wharf: Impact piling behavioural response zones for marine mammals
- Figure 16: Fergusson Wharf: Impact piling behavioural response zones for little penguin

FIGURE 1: BLEDISLOE WHARF VIBRO PILING
TTS ZONES FOR HIGH-FREQUENCY CETACEANS



Calculated underwater noise levels for vibro driving 900 - 1,200 mm diameter steel piles.

Assumed driving rate of 30 minutes driving per pile and up to 2 piles installed per day.

- Piling location
- High-frequency cetacean TTS

Client:
Ports of Auckland Ltd

Authors:
ben.lawrence

Date of Issue:
31/10/2024 12:01 pm

Drawing Details:
Scale: 1:20,000
Projection: NZGD 2000 New Zealand Transverse Mercator
Map Rotation: 0°

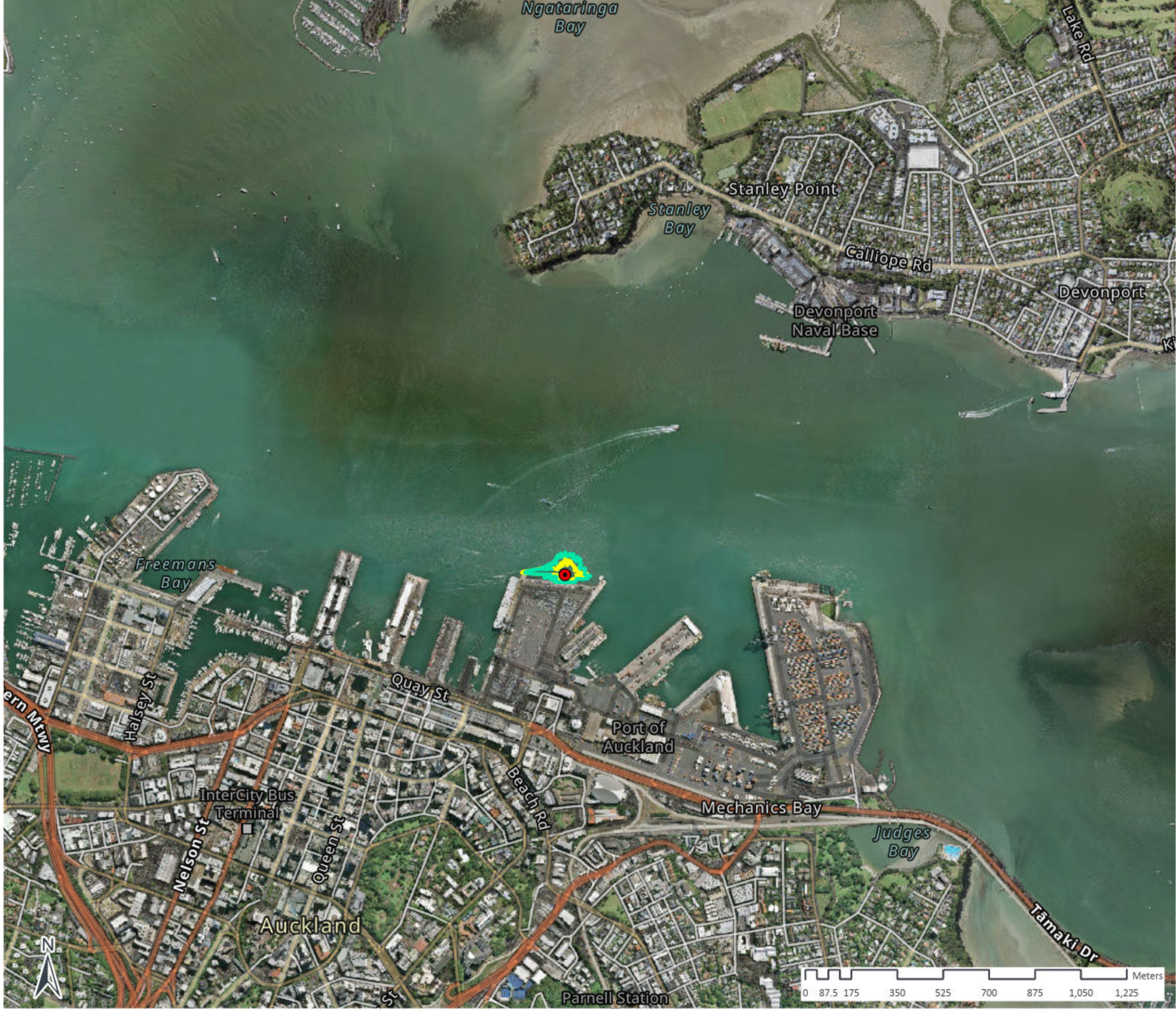
Criteria:
NOAA 2024 non-impulsive TTS criteria:
- high-frequency cetaceans: 181 dB SELcum(HF)

dBSea Details:
Calculation Methods:
dBSeaPE solver form 12.5 - 630 Hz
dBSeaRay from 800 Hz - 125 kHz
Result File Name: dBSea 001 20240240

Map Notes / Comments:
This map is for graphical purposes only. While every effort has been made to ensure that the data are accurate and reliable, Marshall Day Acoustics cannot assume liability for errors or omissions in the data graphically represented.

The noise contours were obtained by interpolations of calculated grid points, with varying interpolation accuracy.

FIGURE 2: BLEDISLOE WHARF VIBRO PILING
TTS ZONES FOR OTARIID AND PHOCID PINNIPEDS



Calculated underwater noise levels for vibro driving 900 - 1,200 mm diameter steel piles.

Assumed driving rate of 30 minutes driving per pile and up to 2 piles installed per day.

- Piling location
- Phocid pinniped TTS
- Otariid pinniped TTS

Client:
Ports of Auckland Ltd

Authors:
ben.lawrence

Date of Issue:
31/10/2024 12:01 pm

Drawing Details:
Scale: 1:20,000
Projection: NZGD 2000 New Zealand Transverse Mercator
Map Rotation: 0°

Criteria:
NOAA 2024 non-impulsive TTS criteria:
- otariid pinnipeds: 179 dB SELcum(OW)
- phociid pinnipeds: 175 dB SELcum(PW)

dBSea Details:
Calculation Methods:
dBSeaPE solver form 12.5 - 630 Hz
dBSeaRay from 800 Hz - 125 kHz
Result File Name: dBSea 001 20240240

Map Notes / Comments:
This map is for graphical purposes only. While every effort has been made to ensure that the data are accurate and reliable, Marshall Day Acoustics cannot assume liability for errors or omissions in the data graphically represented.
The noise contours were obtained by interpolations of calculated grid points, with varying interpolation accuracy.

FIGURE 3: BLEDISLOE WHARF VIBRO PILING BEHAVIOURAL RESPONSE FOR MARINE MAMMALS

Calculated underwater noise levels for vibro driving 900 - 1,200 mm diameter steel piles.

Assumed driving rate of 30 minutes driving per pile and up to 2 piles installed per day.

Piling location

120 dB RMS unweighted

Client:
Ports of Auckland Ltd

Authors:
ben.lawrence

Date of Issue:
31/10/2024 12:01 pm

Drawing Details:
Scale: 1:45,000
Projection: NZGD 2000 New Zealand Transverse Mercator
Map Rotation: 0°

Criteria:
- NOAA non impulsive behavioural response for all marine mammals (120 dB RMS unweighted)

dBSea Details:
Calculation Methods:
dBSeaPE solver form 12.5 - 630 Hz
dBSeaRay from 800 Hz - 125 kHz
Result File Name: dBSea 001 20240240

Map Notes / Comments:

This map is for graphical purposes only. While every effort has been made to ensure that the data are accurate and reliable, Marshall Day Acoustics cannot assume liability for errors or omissions in the data graphically represented.

The noise contours were obtained by interpolations of calculated grid points, with varying interpolation accuracy.

FIGURE 4: BLEDISLOE WHARF VIBRO PILING BEHAVIOURAL RESPONSE FOR KORORĀ

Calculated underwater noise levels for vibro driving 900 - 1,200 mm diameter steel piles.

Assumed driving rate of 30 minutes driving per pile and up to 2 piles installed per day.

- Piling location
- 120 dB RMS unweighted

Client:
Ports of Auckland Ltd
Authors:
ben.lawrence
Date of Issue:
31/10/2024 12:01 pm

Drawing Details:
Scale: 1:45,000
Projection: NZGD 2000 New Zealand Transverse Mercator
Map Rotation: 0°
Criteria:
- Sørensen et al. (2020) behavioural response for penguins (120 dB RMS unweighted)
dBSea Details:
Calculation Methods:
dBSeaPE solver form 12.5 - 630 Hz
dBSeaRay from 800 Hz - 125 kHz
Result File Name: dBSea 001 20240240

Map Notes / Comments:
This map is for graphical purposes only. While every effort has been made to ensure that the data are accurate and reliable, Marshall Day Acoustics cannot assume liability for errors or omissions in the data graphically represented.
The noise contours were obtained by interpolations of calculated grid points, with varying interpolation accuracy.

FIGURE 5: BLEDISLOE WHARF IMPACT PILING
TTS ZONES FOR HIGH-FREQUENCY CETACEANS

Calculated underwater noise levels for impact driving 900 - 1,200 mm diameter steel piles at Bledisloe Wharf for the wharf extension.

Piling with a hydraulic impact hammer with inbuilt dolly/ hammer cushion. Assumed driving rate of 1,000 strikes per pile and up to 2 piles installed per day.

Option of using a single bubble curtain to mitigate underwater noise.

- Piling location
- High-frequency cetacean TTS
- High-frequency cetacean TTS (bubble curtain)

Client:
Ports of Auckland Ltd
Authors:
ben.lawrence
Date of Issue:
31/10/2024 12:01 pm

Drawing Details:
Scale: 1:20,000
Projection: NZGD 2000 New Zealand Transverse Mercator
Map Rotation: 0°
Criteria:
NOAA 2024 impulsive TTS criteria:
- high-frequency cetaceans: 178 dB SELcum(HF)
dBSea Details:
Calculation Methods:
dBSeaPE solver form 12.5 - 630 Hz
dBSeaRay from 800 Hz - 125 kHz
Result File Name: dBSea 001 20240240

Map Notes / Comments:
This map is for graphical purposes only. While every effort has been made to ensure that the data are accurate and reliable, Marshall Day Acoustics cannot assume liability for errors or omissions in the data graphically represented.
The noise contours were obtained by interpolations of calculated grid points, with varying interpolation accuracy.

FIGURE 6: BLEDISLOE WHARF IMPACT PILING TTS ZONES FOR OTARIID AND PHOCID PINNIPEDS

Calculated underwater noise levels for impact driving 900 - 1,200 mm diameter steel piles at Bledisloe Wharf for the wharf extension.

Piling with a hydraulic impact hammer with inbuilt dolly/ hammer cushion. Assumed driving rate of 1,000 strikes per pile and up to 2 piles installed per day.

Option of using a single bubble curtain to mitigate underwater noise.

- Piling location
- Phocid pinniped TTS
- Phocid pinniped TTS (bubble curtain)
- Otariid pinniped TTS
- Otariid pinniped TTS (bubble curtain)

Client:
Ports of Auckland Ltd

Authors:
ben.lawrence

Date of Issue:
31/10/2024 12:01 pm

Drawing Details:
Scale: 1:20,000
Projection: NZGD 2000 New Zealand Transverse Mercator
Map Rotation: 0°

Criteria:
NOAA 2024 impulsive TTS criteria:
- otariid pinnipeds: 170 dB SELcum(OW)
- phocid pinnipeds: 168 dB SELcum(PW)

dBSea Details:
Calculation Methods:
dBSeaPE solver form 12.5 - 630 Hz
dBSeaRay from 800 Hz - 125 kHz
Result File Name: dBSea 001 20240240

Map Notes / Comments:
This map is for graphical purposes only. While every effort has been made to ensure that the data are accurate and reliable, Marshall Day Acoustics cannot assume liability for errors or omissions in the data graphically represented.

The noise contours were obtained by interpolations of calculated grid points, with varying interpolation accuracy.

FIGURE 7: BLEDISLOE WHARF IMPACT PILING BEHAVIOURAL RESPONSE FOR MARINE MAMMALS

Calculated underwater noise levels for impact driving 900 - 1,200 mm diameter steel piles at Bledisloe Wharf for the wharf extension.

Piling with a hydraulic impact hammer with inbuilt dolly/ hammer cushion. Assumed driving rate of 1,000 strikes per pile and up to 2 piles installed per day.

Option of using a single bubble curtain to mitigate underwater noise.

- Piling location
- 120 dB RMS unweighted
- 120 dB RMS unweighted (bubble curtain)
- 160 dB RMS unweighted
- 160 dB RMS unweighted (bubble curtain)

Client:
Ports of Auckland Ltd

Authors:
ben.lawrence

Date of Issue:
31/10/2024 12:01 pm

Drawing Details:
Scale: 1:45,000
Projection: NZGD 2000 New Zealand Transverse Mercator
Map Rotation: 0°

Criteria:
- NOAA non impulsive behavioural response for all marine mammals (120 dB RMS unweighted)
- NOAA impulsive behavioural response for all marine mammals (160 dB RMS unweighted)

dBSea Details:
Calculation Methods:
dBSeaPE solver form 12.5 - 630 Hz
dBSeaRay from 800 Hz - 125 kHz
Result File Name: dBSea 001 20240240

Map Notes / Comments:
This map is for graphical purposes only. While every effort has been made to ensure that the data are accurate and reliable, Marshall Day Acoustics cannot assume liability for errors or omissions in the data graphically represented.

The noise contours were obtained by interpolations of calculated grid points, with varying interpolation accuracy.

FIGURE 8: BLEDISLOE WHARF IMPACT PILING BEHAVIOURAL RESPONSE FOR KORORĀ

Calculated underwater noise levels for impact driving 900 - 1,200 mm diameter steel piles at Bledisloe Wharf for the wharf extension.

Piling with a hydraulic impact hammer with inbuilt dolly/ hammer cushion. Assumed driving rate of 1,000 strikes per pile and up to 2 piles installed per day.

Option of using a single bubble curtain to mitigate underwater noise.

- Piling location
- 120 dB RMS unweighted
- 120 dB RMS unweighted (bubble curtain)

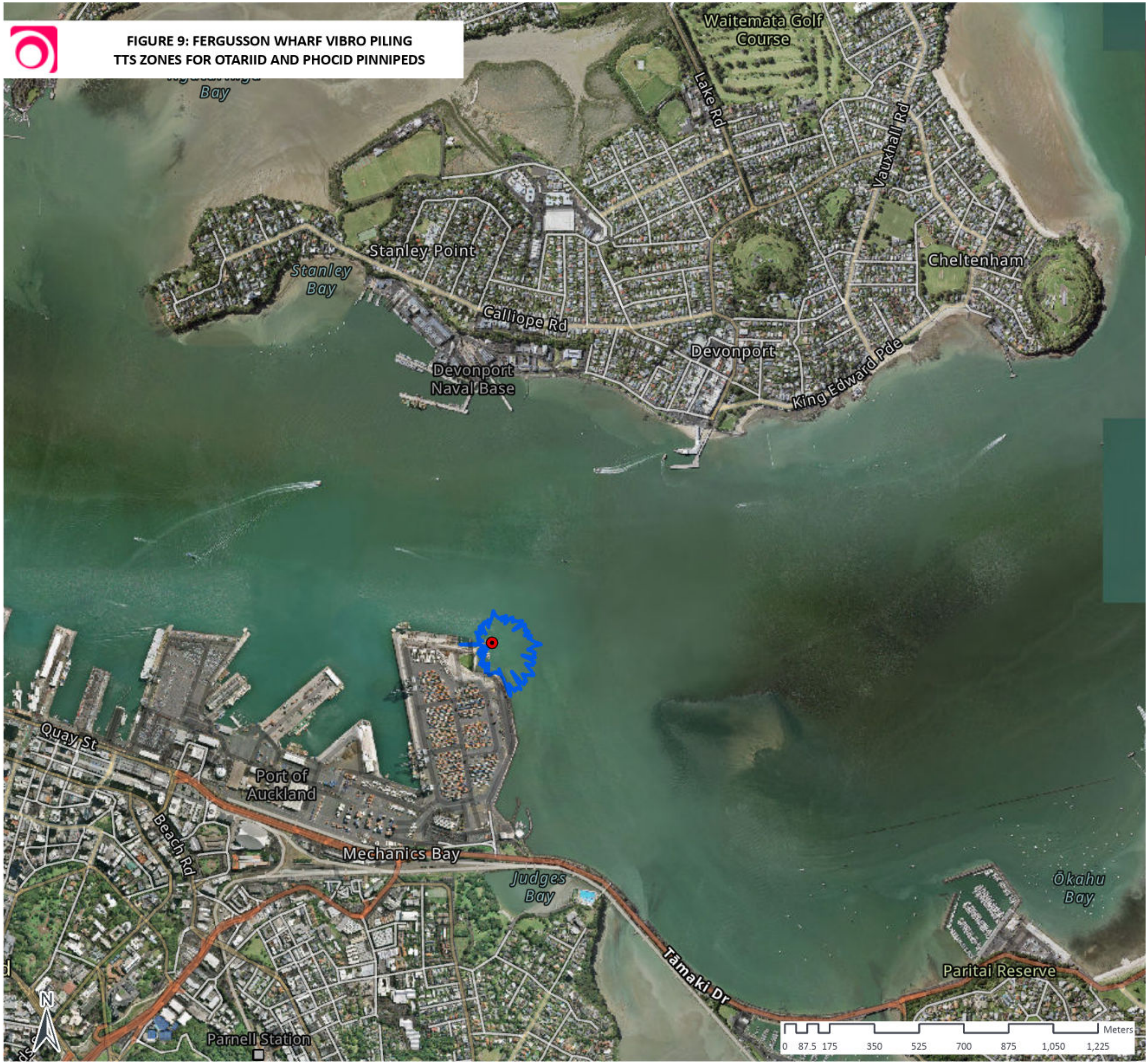
Client:
Ports of Auckland Ltd
Authors:
ben.lawrence
Date of Issue:
31/10/2024 12:01 pm

Drawing Details:
Scale: 1:45,000
Projection: NZGD 2000 New Zealand Transverse Mercator
Map Rotation: 0°
Criteria:
- Sørensen et al. (2020) behavioural response for penguins (120 dB RMS unweighted)
dBSea Details:
Calculation Methods:
dBSeaPE solver form 12.5 - 630 Hz
dBSeaRay from 800 Hz - 125 kHz
Result File Name: dBsea 001 20240240

Map Notes / Comments:
This map is for graphical purposes only. While every effort has been made to ensure that the data are accurate and reliable, Marshall Day Acoustics cannot assume liability for errors or omissions in the data graphically represented.

The noise contours were obtained by interpolations of calculated grid points, with varying interpolation accuracy.

FIGURE 9: FERGUSSON WHARF VIBRO PILING
TTS ZONES FOR OTARIID AND PHOCID PINNIPEDS



Calculated underwater noise levels for vibro driving 900 - 1,200 mm diameter steel piles.

Assumed driving rate of 30 minutes driving per pile and up to 3 piles installed per day.

Piling location

High-frequency cetacean TTS

Client:
Ports of Auckland Ltd

Authors:
ben.lawrence

Date of Issue:
31/10/2024 12:01 pm

Drawing Details:
Scale: 1:20,000
Projection: NZGD 2000 New Zealand Transverse Mercator
Map Rotation: 0°

Criteria:
NOAA 2024 non-impulsive TTS criteria:
- high-frequency cetaceans: 181 dB SELcum(HF)

dBSea Details:
Calculation Methods:
dBSeaPE solver form 12.5 - 630 Hz
dBSeaRay from 800 Hz - 125 kHz
Result File Name: dBSea 001 20240240

Map Notes / Comments:
This map is for graphical purposes only. While every effort has been made to ensure that the data are accurate and reliable, Marshall Day Acoustics cannot assume liability for errors or omissions in the data graphically represented.
The noise contours were obtained by interpolations of calculated grid points, with varying interpolation accuracy.

FIGURE 10: FERGUSSON WHARF VIBRO PILING TTS ZONES FOR OTARIID AND PHOCID PINNIPEDS

Calculated underwater noise levels for vibro driving 900 - 1,200 mm diameter steel piles.

Assumed driving rate of 30 minutes driving per pile and up to 3 piles installed per day.

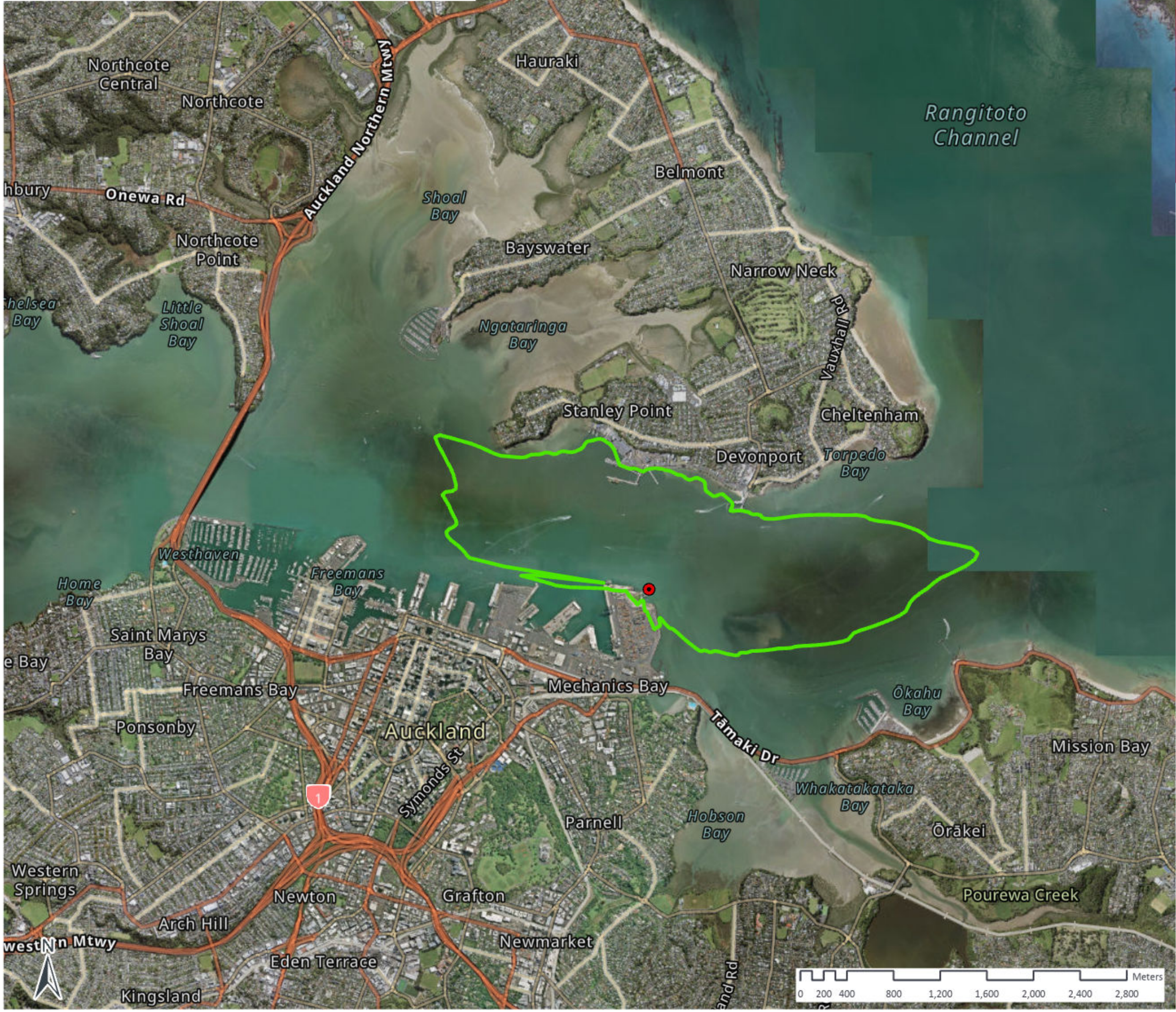
- Piling location
- Phocid pinniped TTS
- Otariid pinniped TTS

Client:
Ports of Auckland Ltd
Authors:
ben.lawrence
Date of Issue:
31/10/2024 12:01 pm

Drawing Details:
Scale: 1:20,000
Projection: NZGD 2000 New Zealand Transverse Mercator
Map Rotation: 0°
Criteria:
NOAA 2024 non-impulsive TTS criteria:
- otariid pinnipeds: 179 dB SELcum(OW)
- phocid pinnipeds: 175 dB SELcum(PW)
dBSea Details:
Calculation Methods:
dBSeaPE solver form 12.5 - 630 Hz
dBSeaRay from 800 Hz - 125 kHz
Result File Name: dBSea 001 20240240

Map Notes / Comments:
This map is for graphical purposes only. While every effort has been made to ensure that the data are accurate and reliable, Marshall Day Acoustics cannot assume liability for errors or omissions in the data graphically represented.
The noise contours were obtained by interpolations of calculated grid points, with varying interpolation accuracy.

FIGURE 11: FERGUSSON WHARF VIBRO PILING BEHAVIOURAL RESPONSE FOR MARINE MAMMALS



Calculated underwater noise levels for vibro driving 900 - 1,200 mm diameter steel piles.

Assumed driving rate of 30 minutes driving per pile and up to 3 piles installed per day.

Piling location

120 dB RMS unweighted

Client:
Ports of Auckland Ltd

Authors:
ben.lawrence

Date of Issue:
31/10/2024 12:01 pm

Drawing Details:
Scale: 1:45,000
Projection: NZGD 2000 New Zealand Transverse Mercator
Map Rotation: 0°

Criteria:
- NOAA non impulsive behavioural response for all marine mammals (120 dB RMS unweighted)

dBSea Details:
Calculation Methods:
dBSeaPE solver form 12.5 - 630 Hz
dBSeaRay from 800 Hz - 125 kHz
Result File Name: dBSea 001 20240240

Map Notes / Comments:

This map is for graphical purposes only. While every effort has been made to ensure that the data are accurate and reliable, Marshall Day Acoustics cannot assume liability for errors or omissions in the data graphically represented.

The noise contours were obtained by interpolations of calculated grid points, with varying interpolation accuracy.

FIGURE 12: FERGUSSON WHARF VIBRO PILING BEHAVIOURAL RESPONSE FOR KORORĀ

Calculated underwater noise levels for vibro driving 900 - 1,200 mm diameter steel piles.

Assumed driving rate of 30 minutes driving per pile and up to 3 piles installed per day.

Piling location

120 dB RMS unweighted

Client:
Ports of Auckland Ltd

Authors:
ben.lawrence

Date of Issue:
31/10/2024 12:01 pm

Drawing Details:
Scale: 1:45,000
Projection: NZGD 2000 New Zealand Transverse Mercator
Map Rotation: 0°

Criteria:
- Sørensen et al. (2020) behavioural response for penguins (120 dB RMS unweighted)

dBSea Details:
Calculation Methods:
dBSeaPE solver form 12.5 - 630 Hz
dBSeaRay from 800 Hz - 125 kHz
Result File Name: dBSea 001 20240240

Map Notes / Comments:
This map is for graphical purposes only. While every effort has been made to ensure that the data are accurate and reliable, Marshall Day Acoustics cannot assume liability for errors or omissions in the data graphically represented.

The noise contours were obtained by interpolations of calculated grid points, with varying interpolation accuracy.

FIGURE 13: FERGUSSON WHARF IMPACT PILING TTS ZONES FOR HIGH-FREQUENCY CETACEANS

Calculated underwater noise levels for impact driving 900 - 1,200 mm diameter steel piles at Bledisloe Wharf for the wharf extension.

Piling with a hydraulic impact hammer with inbuilt dolly/ hammer cushion. Assumed driving rate of 1,000 strikes per pile and up to 3 piles installed per day.

Option of using a single bubble curtain to mitigate underwater noise.

- Piling location
- High-frequency cetacean TTS
- High frequency cetacean TTS (bubble curtain)

Client:
Ports of Auckland Ltd

Authors:
ben.lawrence

Date of Issue:
31/10/2024 12:01 pm

Drawing Details:
Scale: 1:20,000
Projection: NZGD 2000 New Zealand Transverse Mercator
Map Rotation: 0°

Criteria:
NOAA 2024 impulsive TTS criteria:
- high-frequency cetaceans: 178 dB SELcum(HF)

dBSea Details:
Calculation Methods:
dBSeaPE solver form 12.5 - 630 Hz
dBSeaRay from 800 Hz - 125 kHz
Result File Name: dBSea 001 20240240

Map Notes / Comments:
This map is for graphical purposes only. While every effort has been made to ensure that the data are accurate and reliable, Marshall Day Acoustics cannot assume liability for errors or omissions in the data graphically represented.

The noise contours were obtained by interpolations of calculated grid points, with varying interpolation accuracy.

FIGURE 14: FERGUSSON WHARF IMPACT PILING TTS ZONES FOR OTARIID AND PHOCID PINNIPEDS

Calculated underwater noise levels for impact driving 900 - 1,200 mm diameter steel piles at Bledisloe Wharf for the wharf extension.

Piling with a hydraulic impact hammer with inbuilt dolly/ hammer cushion. Assumed driving rate of 1,000 strikes per pile and up to 3 piles installed per day.

Option of using a single bubble curtain to mitigate underwater noise.

- Piling location
- Phocid pinniped TTS
- Phocid pinniped TTS (bubble curtain)
- Otariid pinniped TTS
- Otariid pinniped TTS (bubble curtain)

Client:
Ports of Auckland Ltd

Authors:
ben.lawrence

Date of Issue:
31/10/2024 12:01 pm

Drawing Details:
Scale: 1:20,000
Projection: NZGD 2000 New Zealand Transverse Mercator
Map Rotation: 0°

Criteria:
NOAA 2024 impulsive TTS criteria:
- otariid pinnipeds: 170 dB SELcum(OW)
- phocid pinnipeds: 168 dB SELcum(PW)

dBSea Details:
Calculation Methods:
dBSeaPE solver form 12.5 - 630 Hz
dBSeaRay from 800 Hz - 125 kHz
Result File Name: dBSea 001 20240240

Map Notes / Comments:

This map is for graphical purposes only. While every effort has been made to ensure that the data are accurate and reliable, Marshall Day Acoustics cannot assume liability for errors or omissions in the data graphically represented.

The noise contours were obtained by interpolations of calculated grid points, with varying interpolation accuracy.

FIGURE 15: FERGUSSON WHARF IMPACT PILING BEHAVIOURAL RESPONSE FOR MARINE MAMMALS

Calculated underwater noise levels for impact driving 900 - 1,200 mm diameter steel piles at Bledisloe Wharf for the wharf extension.

Piling with a hydraulic impact hammer with inbuilt dolly/ hammer cushion. Assumed driving rate of 1,000 strikes per pile and up to 3 piles installed per day.

Option of using a single bubble curtain to mitigate underwater noise.

- Piling location
- 120 RMS unweighted
- 120 RMS unweighted (bubble curtain)
- 160 dB RMS unweighted
- 160 dB RMS unweighted (bubble curtain)

Client:
Ports of Auckland Ltd

Authors:
ben.lawrence

Date of Issue:
31/10/2024 12:01 pm

Drawing Details:
Scale: 1:45,000
Projection: NZGD 2000 New Zealand Transverse Mercator
Map Rotation: 0°

Criteria:
- NOAA non impulsive behavioural response for all marine mammals (120 dB RMS unweighted)
- NOAA impulsive behavioural response for all marine mammals (160 dB RMS unweighted)

dBSea Details:
Calculation Methods:
dBSeaPE solver form 12.5 - 630 Hz
dBSeaRay from 800 Hz - 125 kHz
Result File Name: dBSea 001 20240240

Map Notes / Comments:
This map is for graphical purposes only. While every effort has been made to ensure that the data are accurate and reliable, Marshall Day Acoustics cannot assume liability for errors or omissions in the data graphically represented.
The noise contours were obtained by interpolations of calculated grid points, with varying interpolation accuracy.

FIGURE 16: FERGUSSON WHARF IMPACT PILING BEHAVIOURAL RESPONSE FOR KORORĀ

Calculated underwater noise levels for impact driving 900 - 1,200 mm diameter steel piles at Bledisloe Wharf for the wharf extension.

Piling with a hydraulic impact hammer with inbuilt dolly/ hammer cushion. Assumed driving rate of 1,000 strikes per pile and up to 3 piles installed per day.

Option of using a single bubble curtain to mitigate underwater noise.

Piling location
120 dB RMS unweighted
120 dB RMS unweighted (bubble curtain)

Client:
Ports of Auckland Ltd
Authors:
ben.lawrence
Date of Issue:
31/10/2024 12:01 pm

Drawing Details:
Scale: 1:45,000
Projection: NZGD 2000 New Zealand Transverse Mercator
Map Rotation: 0°
Criteria:
- Sørensen et al. (2020) behavioural response for penguins (120 dB RMS unweighted)
dBSea Details:
Calculation Methods:
dBSeaPE solver form 12.5 - 630 Hz
dBSeaRay from 800 Hz - 125 kHz
Result File Name: dBSea 001 20240240

Map Notes / Comments:
This map is for graphical purposes only. While every effort has been made to ensure that the data are accurate and reliable, Marshall Day Acoustics cannot assume liability for errors or omissions in the data graphically represented.
The noise contours were obtained by interpolations of calculated grid points, with varying interpolation accuracy.